

What is claimed is:

Claims

5 1. A method comprising the steps of:

receiving a single orthogonal frequency division multiplexed (OFDM)
symbol that exhibits $1/N$ symbol symmetry, where N is an integer
greater than or equal to 2;

10

determining timing synchronization from the single OFDM symbol by
applying a correlation metric to the single OFDM symbol.

15

2. The method of claim 1, further comprising the step of determining a
fractional subcarrier frequency offset from the single OFDM symbol.

20

3. The method of claim 2, further comprising the step of removing the
fractional subcarrier frequency offset from the single OFDM symbol.

25

4. The method of claim 1, further comprising the step of determining
an integer subcarrier frequency offset from the single OFDM symbol.

30

5. The method of claim 4, wherein the step of determining the integer
subcarrier frequency offset comprises the step of applying differential
correlation to a frequency-shifted version of the single OFDM symbol.

6. The method of claim 4, further comprising the step of performing a
fourier transform on the single OFDM prior to determining the integer
subcarrier frequency offset.

7. The method of claim 1, further comprising the step of determining a subcarrier rotation from the single OFDM symbol.

5

8. The method of claim 7, wherein the step of determining the subcarrier rotation comprises the step of determining an angle for a maximum differential correlation of a frequency-shifted version of the single OFDM symbol.

10

9. The method of claim 1, further comprising the step of utilizing at least the timing synchronization to provide synchronized output symbols in subsequently received bauds.

15

10. The method of claim 1, wherein the step of determining comprises the step of utilizing the correlation metric to update a previously determined timing synchronization.

20

11. The method of claim 1, wherein the single OFDM symbol is an OFDM sync baud.

25

12. The method of claim 1, wherein the single OFDM symbol comprises at least one data symbol.

30

13. The method of claim 1, wherein N is an integer greater than or equal to 3.

14. The method of claim 1, wherein the method is performed by a wireless receiver.

receiving a single orthogonal frequency division multiplexed (OFDM) symbol;

determining timing synchronization from the OFDM symbol;

determining a fractional subcarrier frequency offset from the single OFDM symbol;

removing the fractional subcarrier frequency offset from the single OFDM symbol;

determining an integer subcarrier frequency offset from the single OFDM symbol.

16. The method of claim 15, wherein the step of determining the integer subcarrier frequency offset comprises the step of applying differential correlation to a frequency-shifted version of the single OFDM symbol.

17. The method of claim 15, further comprising the step of determining a subcarrier rotation from the single OFDM symbol.

18. The method of claim 17, wherein the step of determining the subcarrier rotation comprises the step of determining an angle for a maximum differential correlation of a frequency-shifted version of the single OFDM symbol.

30

5

10

15

20

25

24. The method of claim 15, wherein the method is performed by a wireless receiver.

25. An apparatus comprising:

a timing synchronizer, arranged and constructed to obtain timing
synchronization on a single orthogonal frequency division multiplexed
5 (OFDM) symbol;

a fractional subcarrier frequency synchronizer, operably coupled to the
timing synchronizer, wherein the fractional subcarrier frequency
synchronizer is arranged and constructed to obtain fractional subcarrier
10 frequency synchronization on the single OFDM symbol.

26. The apparatus of claim 25, wherein the fractional subcarrier
frequency synchronizer is further arranged and constructed to remove
a fractional subcarrier frequency offset from the single OFDM symbol.
15

27. The apparatus of claim 25, further comprising an integer subcarrier
frequency synchronizer, operably coupled to the fractional subcarrier
frequency synchronizer, wherein the integer subcarrier frequency
20 synchronizer is arranged and constructed to obtain integer subcarrier
frequency synchronization on the single OFDM symbol.

28. The apparatus of claim 25, wherein the integer subcarrier
25 frequency synchronizer is arranged and constructed to apply a
differential correlation to a frequency-shifted version of the single
OFDM symbol.

30 29. The apparatus of claim 25, further comprising a subcarrier rotation
synchronizer, operably coupled to the integer subcarrier frequency
synchronizer and the timing synchronizer, wherein subcarrier rotation
is arranged and constructed to obtain subcarrier rotation
synchronization on the single OFDM symbol.

09832340-06154
TOST-90-0488860

30. The apparatus of claim 25, wherein the subcarrier rotation synchronizer is further arranged and constructed to determine an angle for a maximum differential correlation of a frequency-shifted version of the single OFDM symbol.

31. The apparatus of claim 25, further comprising a fourier transformer that converts the single OFDM symbol to a frequency domain signal.

32. The apparatus of claim 25, wherein the single OFDM symbol is an OFDM sync baud.

33. The apparatus of claim 25, wherein the apparatus is disposed in a wireless receiver.

34. A method comprising the steps of:

receiving a single orthogonal frequency division multiplexed (OFDM) symbol;

determining an integer subcarrier frequency offset from the single OFDM symbol by applying a differential correlation metric to the OFDM symbol.

35. The method of claim 34, further comprising the step of removing a fractional subcarrier frequency offset from the single OFDM symbol prior to the determining step.

36. The method of claim 34, wherein the step of determining the integer subcarrier frequency offset comprises the step of applying the differential correlation metric to a frequency-shifted version of the single OFDM symbol and a known OFDM sync baud.

38. The method of claim 34, further comprising the step of determining subcarrier rotation by determining an angle of a maximum for the differential correlation metric.

39. The method of claim 34, wherein the differential correlation metric
10 comprises applying the equation

$$R(s) = \sum_{k=0}^{L-3} [x^*(k)y((k+s) \bmod L)] \cdot [x^*(k+2)y((k+2+s) \bmod L)],$$

40. The method of claim 34, wherein the integer subcarrier frequency
20 offset, γ_2 , is computed using the following formula

$$\gamma_2 = \Delta f \cdot s_{rem} \text{ where } s_{rem} = \arg \max_s |R(s)|,$$

where Δf is subcarrier spacing and $|R(s)|$ is the magnitude of the
25 differential correlation metric.

41. A method comprising the steps of:

receiving a single orthogonal frequency division multiplexed (OFDM)
symbol that exhibits $1/N$ symbol symmetry, where N is an integer
5 greater than or equal to 2;

determining a subcarrier rotation from the single OFDM symbol.

10 42. The method of claim 41, further comprising the step of determining
timing synchronization from the single OFDM symbol by applying a
correlation metric to the single OFDM symbol.

15 43. The method of claim 41, further comprising the step of determining
a fractional subcarrier frequency offset from the single OFDM symbol.

20 44. The method of claim 41, further comprising the step of determining
an integer subcarrier frequency offset from the single OFDM symbol.

25 45. The method of claim 41, further comprising the step of utilizing at
least the subcarrier rotation to provide synchronized output symbols in
subsequently received bauds.

30 46. The method of claim 41, further comprising the step of utilizing at
least the subcarrier rotation to update previously determined
synchronization information.

35 47. The method of claim 41, wherein the single OFDM symbol is an
OFDM sync baud.

48. The method of claim 41, wherein the method is performed by a wireless receiver.

09332840 061501
FOSTER 07282860